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The cement industry in the United States

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THE CEMENT INDUSTRY IN THE UNITED STATES

BY

HAROLD BERTRAM PROUT

THESIS FOR THE DEGREE OF BACHELOR OF ARTS IN ECONOMICS

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IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

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TABLE OF CONTENTS.

Chapter 1, A Brief Review of the Industry, -----	Page 2.
Chapter 2, The Economies of Cement-----	Page 29.
Chapter 3, The Present Status of the Industry-----	Page 45.
Bibliography-----	Page 60.



THE CEMENT INDUSTRY IN THE UNITED STATES.

Chapter 1.

A BRIEF REVIEW OF THE INDUSTRY.

Introduction-- Brief history of cement --Its production and transportation--Imports and exports.

Considering the fact that the manufacturing of cement ranks among our largest industries, its history, as compared with that of other leading industries, covers a very short space of time. It is true that the ancients used cement, but it was not the kind with which we are familiar. The cement used by the Romans was made by mixing slaked lime with powdered volcanic ash. This went out of use and it was not until toward the end of the eighteenth century that cement began to be used again. A kind of burned cement was then employed which developed into what is now called Natural cement.

Natural cement was first manufactured¹ in the United States in 1819; its component materials were discovered in digging the Erie Canal through central New York. From that time onwards the manufacture of natural cement spread rapidly in this country.

In 1824, a patent was taken out in England² for Portland cement, so named because of a rather fanciful resemblance between the set cement and a favorite English building stone. The growth of this industry was slow at first, but by 1850, a distinct increase in

1. Brown, Directory of American Cement Industries. P. 11 & 12.
2. E. C. Eckel, The P. C. Industry from a Financial Standpoint.

outout had taken place in England and in Germany. Henceforward Portland cement began gradually to displace the older natural cements in all markets. Notwithstanding this advance in the Portland cement industry in England, it was not introduced into America until 1875, the first place of successful manufacture being Wampum, Penn. Soon afterwards a plant was established in the now-famous Lehigh district. The laborious processes by which Portland cement was made in Europe were not suited to the high priced labor of this country, and before the industry could make much headway in the United States, the methods of manufacture had to be changed so as to cut down the amount of labor necessary in both the burning and the grinding processes. These changes were made by the substitution of the modern grinding machines and the rotary kilns for the old millstones and stationary kilns.

On account of the late beginning of the industry in this country, foreign cements obtained a good foothold¹ here before there was home competition. Although the manufacture of Portland cement in the United States is growing rapidly, there is still some demand for foreign cement. The increase in American manufacture has, until the past year, been scarcely large enough to supply the increase in demand. In 1891, only 13.2% of the cement used in the United States was of American manufacture, while in 1899 this had risen to 73.9%. In 1900, out of 1,410,683 barrels imported, only 11% came from the United Kingdom. German cement had the largest sale, supplying 46%, while Belgian cements came next with 34%. There was considerable

1. The Architect and Contract Reporter, July 19, 1901, article by Mr. Bell, British Commercial Agent in the United States.

difference of opinion as to why German and Belgian cements were sold more than the English. The British product, at one time the only Portland cement in our market, was replaced by German cement because of the superior quality of the latter. Then there was a large number of German masons in this country, and they naturally preferred a product from their homeland. The Belgian cement obtained a foothold on account of its low price, but the quality was inferior to that of the other cements. The low price of American cements has nothing to do with quality, but is due largely to the competition of manufacturers. Tests made by competent engineers show that the best American cements are superior to all others. Some people prefer to use imported cements regardless of cost.

The great development of the American cement industry¹ is due to two causes. The first is the increase in population together with the increase in the kinds of work for which cement is used. The second is the development of labor-saving processes for manufacture thus reducing the cost and making it possible to use cement for many constructions from which it had been largely excluded on account of the relative cheapness of other materials. The increase in the price of lumber was, of course, a contributing factor.

When Ransome first patented the rotary kiln², he made his cement by the wet process, and used gas for fuel. With his small kilns, this proved to be a failure, but the Atlas Portland Cement Company took up the rotary kiln, and, with the more favorable hard and dry materials of the Lehigh Valley, finally made a success of it. Crude oil was tried for fuel, but now powdered coal is used wherever it

1. Brown, Directory of American Cement Industries. P. 16-18.

can be obtained at a reasonable price. With the success of this kiln, the Portland cement industry in this country began in earnest. At present it is possible for the raw material to pass from the freight cars to the finished package of cement without being touched by hand, and this saving in labor cost enables the American manufacturer to compete successfully with any country in the world.

The present state of the cement industry² in the United States cannot be determined by looking at the situation from a single point of view. The pioneer manufacturer, accustomed to little competition and large profits, would like to return to the conditions of former years. To him possibly the industry may not appear as prosperous as it should be. On the other hand, those engaged in the manufacture of brick and other clay products, see in the cement industry a growing monster eating up their trade and threatening to destroy them. From the standpoint of the consumer, cement has never been so cheap and of such good quality. As shown by the actual figures, the production in 1908 was over fifty-one million barrels, valued at approximately forty-four million dollars, whereas during the preceeding year the production was about forty-nine million barrels valued at fifty-four million dollars. This increase of about two million barrels in production and decrease of about ten million dollars in value was due largely to the competition brought about by the recent financial depression, but it serves to show the needs of the country and also the extent to which competition has developed. The realization of this is likely to operate on the industry in several ways. It will tend to confine the establishment

1. Cement Age, Dec. 1909.

of new plants not allied with other concerns, to localities where large demand for cement exists, but which are so far removed from mills now in operation that the freight rates materially raise the cost to the consumer. Where new companies are formed in territory already occupied they will probably be allied with concerns already established, thus representing an increased capacity rather than strictly new enterprises. Such expansion will depend upon established trade and brands, and the economy attending manufacturing on a large scale, to enable them to produce cement at a fair profit. Upon its present basis, and with the present consumption, the cement industry easily holds its place among the important industries of the country. There is every promise that conditions will show constant, if not rapid improvement, and there is not the slightest indication that the demand for cement will grow less, but on the other hand, there is every reason to prophesy increasing demand. In 1908, much was said concerning the abandonment of important structural enterprises requiring the use of cement. Since that time several have been completed and many new projects are under way. Everywhere there is a demand for progress, and cement is instrumental in bringing this about through the accomplishment of hitherto impossible engineering feats.

The phenomenal growth² of the American Portland cement industry during the last few years has created a widespread interest in the raw materials, the methods of manufacture, and the uses of cement. The interest is not confined to those who are financially concerned, but is universal among all classes of progressive people. In 1. Bulletin #243 of the Geological Survey.

its importance to our present civilization, cement is surpassed among mineral products only by iron, coal, and oil, and in the rate of increase of production it surpasses everything but gold.

The interest of the general public in cement construction¹ is shown by the fact that in all parts of the country, daily newspapers are establishing departments devoted to this subject. In the attention it attracts, cement occupies a unique position among building materials. The following is an illustration of how cement construction has grown in popularity:²"A Chicago man, writing on the subject of concrete construction, states that he was unable, five years ago, to obtain a loan with which to build a small concrete house, but now the same men who refused the loan are building concrete houses for themselves". Another evidence³ of the general interest in cement construction comes from Philadelphia. The Central Y. M. C. A. of that city recently had Mr. Emil G. Perrot, a prominent engineer, give a series of lectures on "Reinforced Concrete in Building Construction". Although the general public had to pay for hearing these lectures, there was a large attendance at all of them.

The growing importance³ of the cement industry may be seen in the fact that most engineering schools deem it necessary for their classes to visit and know something about a cement manufacturing plant. As every large engineering project involves the use of concrete, it is necessary that the future engineer should be familiar with it before he leaves school. This trend of affairs is only

1. Cement Age, Vol.4, P.188.

2. Cement Age, Vol.8, P.59. 3.Cement Age, June, 1907.

the natural sequence of the remarkable progress recently made in the manufacture of cement, and its application to structural work of every description.

The present indications¹ are that the cement industry is expanding more than the most optimistic forecaster predicted. All over the country, the number of concrete buildings planned or under way is large. In spite of a few failures due to lack of care or knowledge, concrete has made good, notwithstanding the opposition of bricklayers and allied trades unions, and those dealers or manufacturers of materials with which cement comes into competition.

The demand for cement is increasing² all over the world, but nowhere as fast as in the United States. Not only does the United States manufacture and use more cement than any other country, but industrial and commercial conditions are such that the industry has been successful in every sense of the word.

The three classes of cement³ which are on the market are Natural, Puzzolan, and Portland. Natural cement is cement made by crushing natural cement rock, then burning it and pulverizing it between buhr stones. Puzzolan cement is a product obtained by intimately and mechanically mixing, without subsequent calcination, powdered hydrates of lime with natural or artificial materials which generally do not harden under water when alone, but do so when mixed with hydrates of lime, the mixed product being ground to extreme fineness. Portland cement is a cement made from an artificial mixture of materials containing lime, silica, and

1. Cement Age, Vol.4, P.215. 2. Cement Age, Vol.4, P.3 & 7.
3. Brown, Directory of American Cement Industries. P.10-12.

alumina in proper proportions, and burned or calcined up to incipient fusion of the intimate mixture.

According to a report¹ of the Chamber of Commerce of Marseilles, France, made in 1905, the world's production of cement for the previous year was as follows:-

Country.	Amount.
United States	3,000,000 tons.
Germany	2,500,000 "
England	1,500,000 "
Belgium	685,000 "
France	555,000 "
Russia	500,000 "
All others	500,000 "

Since that time the proportion of the United States has very materially increased.

From the commercial standpoint the cement industry has not been entirely gratifying to the manufacturer during the past year. Commercial depression was the characteristic of 1908, especially with respect to many of the materials of construction, yet the figures show an increase of five per cent in the production of cement. From the results of 1908, it seems probable that the extensive publicity given to the numerous new uses of Portland cement and the widespread desire on the part of consumers and contractors all over the United States to try the new material of construction, and to find new outlets for its consumption, have born fruit.

Before taking up the statistics relating to the three kinds of cement, it may be well to give the total production of the United States. The total quantity¹ of Natural, Puzzolan, and Portland cement produced in 1908 was 52,910,925 barrels, valued at \$44,477,653. As compared with 1907 (52,230,343 barrels, valued at \$55,903,851), the year 1908 showed an increase of 1.3% in quantity and a decrease of 20% in value. The increase in quantity is the smallest ever recorded and the heavy decrease in value indicates the serious trade conditions which the cement industry encountered in 1908.

The distribution of the total production among the three main classes is shown in the following table.²

Total production of cement in the United States in 1906, 1907, 1908

1906.

Class.	Quantity (bbls.)	Value.
Portland	46,463,424	\$52,466,186.
Natural	4,055,797	2,423,170.
Puzzolan	481,224	412,921.
Total	51,000,445	\$55,302,277.

1907.

Portland	48,785,390	\$53,992,551.
Natural	2,887,700	1,467,302.
Puzzolan	557,252	443,998.
Total	52,230,342	\$55,903,851.

1. E. C. Eckel, The Cement Industry in the United States in 1908 (U. S. Mineral Resources, 1908) P.3.

1908.		
Class.	Quantity (bbls.)	Value.
Portland	51,072,612	\$43,547,679.
Natural	1,686,682	834,509.
Puzzolan	<u>151,451</u>	<u>95,468.</u>
Total	52,910,745	\$44,477,653.

The increase¹ in production of Portland in 1908, as compared with 1907, was 4.6% and the decrease in value was 19.3%. The following table² shows the growth in production of Portland cement since 1880.

Year.	Quantity (bbls.)	Value.
1880	42,000	\$ 126,000.
1885	150,000	292,500.
1890	335,500	704,050.
1895	990,324	1,586,830.
1900	8,482,020	9,280,525.
1905	35,246,812	33,245,867.
1908	51,072,612	43,547,679.

All of the older producing states², especially in the East, showed heavy decreases in output during 1908, while a relatively small number of plants, mostly in the middle West, reported large increases. The only really large producer to report an increase was the United States Steel Corporation whose production increased from 2,129,700 barrels in 1907 to 4,535,300 barrels in 1908. This fact is interesting because this gain represents more than the increase for the entire country.

1. U. S. Mineral Resources, 1908, P.4 & 5.

In the following table⁴ the Portland cement industry has been grouped by states according to the amounts produced in 1908.

State.	Plants in operation.	Quantity(bbls.)	Value.
Pennsylvania	17	18,254,806	\$13,899,807.
Indiana	7	6,478,165	5,386,563.
Kansas	7	3,854,603,	2,874,457.
Illinois	5	3,211,168	2,707,044.
New Jersey	3	3,208,446	2,416,009.
Michigan	15	2,892,576	2,556,215.
Missouri	4	2,929,504	2,571,236.
California	4	2,480,100	3,268,196.
Washington	2		
New York	7	1,988,874	1,813,623.
Ohio	8	1,521,764	1,305,210.
Iowa	1	1,205,251	1,176,499.
Kentucky	1		
Tennessee	1		
Texas	2	917,977	924,039.
Oklahoma	2		
South Dakota	1	809,306	1,057,433.
Colorado	2		
Arizona	1	507,603	805,235.
Utah	2		
Maryland	1	502,225	511,118.
Virginia	1		
Massachusetts	1		
Alabama	2	310,244	274,995.
Georgia	1		
Total	98	51,072,612	\$43,547,679.

The Portland cement industry exhibits the same tendency toward
 1. U. S. Mineral Resources, 1908, P. 5.

geographic centralization, though to a less degree, that is characteristic of the iron industry. The following tables¹ ~~will~~ show the geographic distribution of the industry. In the "East" the plants are those in Pennsylvania, New Jersey, New York, and Massachusetts. The "Central" plants are those in Ohio, Michigan, Indiana, Illinois, Iowa, and Missouri. In the "West" the plants are those in Kansas, Colorado, South Dakota, Utah, and Arizona. On the "Pacific Coast" there are plants in California and Washington. In the "South" plants are located in Maryland, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Oklahoma, and Texas.

District.	1905. Output(bbls.)	1906.
East	19,589,675	25,483,025
Central	10,723,802	14,030,665
West	2,470,349	3,834,656
Pacific Coast	1,225,429	1,310,435
South	<u>1,237,557</u>	<u>1,804,643</u>
Total	35,246,812	46,463,424
	1907.	1908.
East	27,134,816	23,472,126
Central	13,479,703	17,744,034
West	4,463,397	5,171,512
Pacific Coast	1,893,004	2,480,100
South	<u>1,814,470</u>	<u>2,204,840</u>
Total	48,785,390	51,072,612

1. U. S. Mineral Resources, 1908, P.6.

District. Plants in operation.

	1905	1906	1907	1908
East	30	31	34	28
Central	32	34	37	40
West	7	8	10	13
Pacific Coast	3	4	5	6
South	<u>7</u>	<u>7</u>	<u>8</u>	<u>11</u>
Total	79	84	94	98

District Percentage of total output.

	1905	1906	1907	1908
East	55.6	54.9	55.6	46.0
Central	30.4	30.2	27.6	34.7
West	7.0	8.2	9.2	10.1
Pacific Coast	3.5	2.8	3.9	4.9
South	<u>3.5</u>	<u>3.9</u>	<u>3.7</u>	<u>4.3</u>
Total	100.0	100.0	100.0	100.0

In this connection it is interesting to note the materials¹ from which this Portland cement is made and the tendency as the production increases.

Year.	Cement rock and pure limestone.	Limestone and clay or shale.	Marl and clay.	Slag and limestone.
	Quantity(bbls.)	Quantity	Quantity	Quantity
1898	2,764,694	365,408	562,092	-----
1900	5,960,739	1,034,041	1,454,797	32,443
1902	10,953,178	3,738,303	2,220,453	318,710
1904	15,173,391	7,526,323	3,332,873	473,294

1. U. S. Mineral Resources, 1908, P. 11.

Year.	Cement rock and pure limestone.	Limestone and clay or shale.	Marl and clay.	Slag and limestone.
	Quantity	Quantity	Quantity	Quantity
1906	23,896,951	16,532,212	3,958,201	2,076,000
1908	20,678,693	23,047,717	2,811,212	4,535,300
	Percentage	Percentage	Percentage	Percentage
1898	74.9	9.9	15.2	
1900	70.3	12.2	17.1	0.4
1902	63.6	21.7	12.9	1.8
1904	57.2	28.4	12.6	1.8
1906	51.4	35.6	8.5	4.5
1908	40.6	45.0	5.5	8.9

The natural cement produced in the United States during 1908 amounted to 1,686,862 barrels, valued at \$834,509, as compared with an output of 2,887,000 barrels, valued at \$1,467,302 in 1907, a decrease in 1908 of 1,200,838 barrels or over 41% in quantity and of \$632,793 or over 43% in value. The natural cement industry reached its height in 1899, with an output of 9,868,179 barrels. Since that year it has shown an almost continuous and quite rapid decline, until now it has become a relatively unimportant factor in the cement situation. The growth and decline of the industry is shown in the following table.

Year.	Quantity (bbls).
1880	2,030,000
1885	4,100,000
1890	7,082,204

Year.	Quantity (bbls).
1895	7, 741, 0 77
1900	8,382,519
1905	4,473,049
1908	1,686,682

From the point of view of geographic distribution the following table¹ shows the natural cement industry in 1908 classified according to states.

State.	Producing plants.	Quantity (bbls).	Value.
New York	6	623,618	\$441,136
Pennsylvania	3	252,479	87,192
Indiana	3	212,901	42,580
Illinois	2	188,859	68,772
Kansas	2		
Texas	1	87,159	47,725
Colorado	1		
Kentucky	2		
Georgia	1	119,656	53,904
Ohio	1		
Minnesota	2		
Wisconsin	<u>1</u>	<u>202,190</u>	<u>93,200</u>
Total	25	1,686,862	\$834,509

Puzzolan cement was first manufactured in the United States in 1896. The following table² shows the production.

Year.	Quantity (bbls).
1896	12,260
1898	150,895
1900	446,609

1. U. S. Mineral Resources, 1908, P.12.

2. U. S. Mineral Resources, 1908, P.13.

Year.	Quantity(bbls).
1902	4 78,555
1904	303,045
1906	481,224
1908	151,451

In 1908 there were only four factories producing Puzzolan cement. One was in Alabama, two in Ohio, and one in Pennsylvania.

The United States Geological Survey recently reported that the cement industry in this country had reached a stage where the output was ahead of the demand. This statement² was made during the recent lull in industry, which was largely due to the fact that the manufacturers, having concentrated their energies on large contracts and big construction work, had practically neglected the larger field of cement for everyday use. While such work takes a comparatively small amount for each job, the aggregate will be found considerable when this field is energetically pushed. All that is needed is a proper amount of educational work through demonstrations and the co-operation of dealers and manufacturers. The one thing necessary is to bring the issue before the public in a popular manner, so that they will realize the wonderful adaptability of cement. There are 6,000,000 farms in the United States which could easily use an average of ten barrels apiece, and there are numerous instances of where a large quantity of cement could be used in these small lots. Then there is certain to be a continued large demand for city and town work, railroads, and government work. Again, the number of new buildings erected each year averages about

1. Cement Age, Vol. 8, P. 447.

one per cent of the structures in existence. There are at present about 15,000,000 buildings in the United States, which means that 150,000 new ones must be built each year. Allowing twenty barrels for each building, 30,000,000 barrels would be used. The 150,000 mines and quarries could easily use 100 barrels apiece for props, engine foundations, shaft repairs, ditchings, and retaining walls. The railroads could readily use 100 barrels per mile per year, if we include stations, bridges, abutments, terminals, culverts, ties, etc. For their 300,000 miles of track this would be 30,000,000 barrels of cement. The requirements for municipal work could easily take care of the remaining 15,000,000 barrels of the maximum capacity of our mills. There must also be taken into account the demands for large amounts of cement for public works and irrigation projects, for factories, for 25,000 miles of trolley road, and for canal construction. With the field properly and energetically cultivated, it seems that the difficulty of the cement manufacturers will be to keep up with the demand.

As regards the actual annual output¹, we may safely expect this to increase with the population, and proportionately as new uses are found for cement. But we cannot expect that this increase will be as steady as it has been in the past. In attempting to gain some idea of the possible future development of the cement industry so far as active output is concerned, recourse must be had to comparative studies. For many reasons the manufacture of pig iron affords a close trade parallel to that of cement. Both products

1. Eckel, The Portland Cement Industry from a Financial Stand.

are cheap, bulky, dependent on fuel supplies, and freight rates. Both require heavy investment in plant, as compared with the value of their output. Both products are used extensively in a way which keeps them in close sympathy with business conditions, and both products are, in this country, used at a per capita rate which is still increasing on the average. The cement industry increased at a very rapid rate up to 1907; it showed the normal growth of a healthy young industry, but since then, like other mature industries, it has shown the effects of financial and industrial conditions. Many manufacturers seemed to think that the rapid growth of the industry would continue indefinitely, but of course such could not be the case, and we may expect the future course of the industry to correspond with the general prosperity of the country.

Perhaps the most striking feature² connected with the Portland cement industry has been the steady decline in cement prices during the past thirty years. The decline has, as a matter of fact been as steady and as marked as the growth in annual output. The following table² shows the average price per barrel in bulk at the point of manufacture. This price excludes the cost of the package.

Year.	Price.
1870-80	\$3.00
1882	2.01
1884	2.10
1886-88	1.95

1. Eckel, The P. C. Industry from a Financial Standpoint.

2. U. S. Natural Resources, 1908, P. 10.

Year.	Price.
1890	\$2.09
1892	2.11
1894	1.73
1896	1.57
1898	1.62
1900	1.09
1902	1.21
1904	.88
1906	1.13
1908	.85

As a result of the great reduction in the price of cement during 1908, promotions of cement mills were materially lessened. The method of quotation for deliveries of cement, practised generally throughout the trade, of including in the selling price the cost of the bags, gives a price which is frequently used by promoters to indicate the figure at which cement produced in a new plant can be sold. Thus the average selling price of cement in 1908 was \$1.25 per barrel at the mill, including the bags which were charged at forty cents.

The extremely low price² of Portland cement accounts for the large falling off in the sale of Natural and Puzzolan cements during 1908. That year closed with large stocks of cement on hand, and a very limited demand. As conditions now are, the Portland cement industry is characterized by moderate and decreasing returns

1. The P. C. Industry from a Financial Standpoint.

to the investor, due largely to the fact that free competition is slowly but steadily pushing down the selling price of the product, while, on the other hand, the manufacturing costs are almost stationary. The decline in prices seems to be grouped into four periods, each of which was marked by some change for the better in the manufacturing process. The following table² shows the average price during each period.

Year.	Price (per bbl.)
1874-1880	\$3.00
1881-1894	2.01
1895-1899	1.56
1900-1907	1.07

The future decrease² in prices cannot be compared with that which has already been experienced, since manufacturing costs show little prospect of marked decrease. Under the stimulus of decreased profits for better mills, and of actual losses for the mills which are more poorly located or operated, some attempt at regulation of output and prices may be expected. Such regulation may be made effective through simple pooling, through patent control, or through closer consolidation; the two latter methods offering greater possibilities in this line.

With every improvement in transportation² the competition becomes keener through the advent of new producers, while at the same time it becomes more difficult to make rational forecasts of the course of trade. One might say that the normal course of

1. U. S. Mineral Resources, 1908, P.10.
2. The P. C. Industry from a Financial Standpoint.

modern trade was that prices should always tend toward the cost of production, that this tendency developed itself with increasing speed, and from time to time resulted in production at a loss.

The simplest form of price regulator is the pool¹, but as pools are without legal protection, they are not safe. Experience in both railroad and iron affairs has shown that the so-called "gentlemen's agreement" has a short life. It is of course possible that the Sherman law may be so modified or so re-interpreted as to afford legal remedies for broken price agreements, but as conditions are at present, no form of pool can be considered durable. The usual history of such arrangements has been that the pool was formed during a period of unduly low prices, when everybody was willing to agree to anything; that prices were advanced to remunerative levels, and finally to excessive levels; and that as soon as this caused a slackening in demand, price-cutting became obvious. During the past thirty years the American natural cement industry has developed several pools, some of very simple type and others more complex and having considerable stability. In the Portland cement industry local price agreements are formed at intervals, but none of these has had any great length of life. Of course, any good system of price control must regulate the price in both directions. This has been accomplished fairly well in the steel industry, but since it has been seen that no form of pooling is effective to maintain prices of any commodity at reasonably profitable levels, it is clear that some other type of price regulation must be expected to appear in the cement industry. During the past

1. The P. C. Industry from a Financial Standpoint. Eckel.

few years, two distinct movements in the trade have become noticeable, and one or both of these may aid in the solution of the problem. The first, which is the normal occurrence in any industry containing a large number of independent competitive units, is the gradual growth of the community of interest, which, by increasing the size of some of the units, or decreasing their number, aids in giving stability to the market. The second important movement is towards a control of the trade through the ownership of patents. This form of regulation, though not entirely new in American industrial history, is still much rarer than the other type.

In determining the location for a new plant¹, no possible advantages in the way of raw material can make up for the lack of a good local market. Of course in a rapidly growing section, allowance may be made for future growth of the market, but at least part of the market must be there by the time the plant is finished.

Regardless of what may be effected along the line of price regulation², it is probable that marketing conditions will, in the near future, be improved in some respects. Among the points to which attention may be directed in this field, are the elimination of the "optional contract"; the development of a warrant system, and the establishment of fixed basing points for quotations. Since its commencement in this country, the cement industry has suffered, in common with all other manufacturing industries dealing with basic staples under a highly competitive regime, from a lax regard

1. Eckel, The P. C. Industry from a Financial Standpoint.

for contract obligations by purchasers. A buyer placing a future order for cement or iron, felt apparently no obligation to take the product if the market price fell in the meantime. A contract was treated as if it had been a free option, to be taken only if prices advanced. The worst feature of the situation was that even when a buyer had cancelled such a contract because prices went against him, he felt perfectly assured that the lapse would not be remembered when he next wished to make a similar contract, for the pressure of competition prevented too close a scrutiny of a purchaser's record in this line. It is a fair assumption that the first result of increasing concentration of control will be to eliminate this abuse, as has been done in other industries.

Before railroads were common,¹ cement was put up in barrels because they were easier to handle for transportation than any other kind of package. At present all of the cement works of this country are located on railroads or canals, and the expensive wooden packages have, in a large measure, except for the export trade, been replaced by paper and cloth sacks, resulting in a saving to the consumer of the difference between the cost of paper and wood packages. In the case of cloth sacks, the manufacturer charges a slight advance over the price of the bulk cement to cover the wear on them. Because, when lined with paper, the barrels keep out the moisture, they seem to be almost indispensable for the export trade, although they cost about twenty-two cents apiece. In shipping cement² it is put into barrels, or cloth or

1. Cummins, American Cements, P.213.

2. Cement Age, Vol. P.447.

paper sacks, as ordered. Four sacks make a barrel of Portland cement, which contains 380 pounds, net, and 100 barrels make a carload. Three sacks of natural cement make a barrel, containing 300 pounds, net.

As Portland cement is a cheap and bulky product¹, special attention should be paid to the shipping facilities of the location at^{which} a plant is to be erected. It must be on transportation routes which give access to the important markets, or else a large plant is not justified. The rates must be low enough to put the new plant at least on an equal basis with its nearest competitors, and the road must be able to furnish good car service at all times of the year. It is obvious that a cement plant on only one transportation route is at a disadvantage. There is also a certain advantage in having a navigable river or canal at hand.

The United States does not export² much cement because it does not generally have any surplus, and the freight rates are too high (England and Continental ports having the advantage). During shipping wars or during financial depression, cement has been exported, but on account of the high transportation rates the American manufacturers have not tried to get the foreign trade.

Ten years ago³, when the market was capable of absorbing all of the domestic output even during times of general business depression, the export trade received scant attention. Today, when depression means complete shutdown to many cement mills, the situation is very different, and a marked effort to develop foreign

1. Eckel, The P. C. Industry from a Financial Standpoint.

2. Cement Age, Vol. 1, P. 219.

trade may now be expected. The countries to the south of the United States are, in general, scantily supplied with fuel, and few of the existing Spanish-American coal fields are well located with regard to transportation routes and markets. For this reason alone, these countries offer a very favorable field for cement exports from the United States, and as their development progresses, this field may be expected to expand rather than to contract. While a competitive export trade is not of itself as profitable as a home market, it affords a valuable balance-wheel to domestic trade conditions. Under ordinary circumstances there is always surplus capacity in the manufacture of staples. With depression at home, the surplus becomes disastrous unless there is some way of disposing of it elsewhere, at cost or below it if necessary. In 1906,¹ cement could be delivered on board ship at New York for from \$1.70 to \$1.80 per barrel, in bags, with a rebate of seven and one-half cents per bag when returned. During the same year the average price of cement in bulk at the mill was \$1.13 per barrel. As transportation charges have remained about stationary, there is now just about the difference shown above in prices at the mill and on board ship.

The United States possesses a very small export trade² in cement, the amount thus disposed of ranging between one and three per cent of the domestic production. There are good possibilities ahead and this branch may soon become a more important feature of the industry. The Marseilles, France, Chamber of Commerce³

1. Cement Age, Vol.3, P.375. 3. Cement Age, Vol.3, P.94-5.
2. Eckel, The P. C. Industry from a Financial Standpoint.

reported that it would not be surprised to see the United States become a large exporter of cement in a short time. There is a French discriminating duty¹ of 25 centimes (\$.048) per 100 kilos (22 lbs/) against American cements, because they are subject to the maximum duty. The following table² gives the quantity and value of all cement exported from the United States from 1900 to 1908, inclusive.

Year.	Quantity (bbls.)	Value.
1900	100,400	\$ 225,306
1902	340,821	526,471
1904	774,940	1,104,086
1906	583,299	944,886
1908	846,528	1,249,229
1909 ³	1,056,922	1,417,534

There has always been a moderate tariff on importations of cement. From 1890^{4,5} until the passage of the Tariff of 1909, the duty on Roman, Portland, and other hydraulic cements was eight cents per hundred pounds, in packages, or seven cents per hundred pounds in bulk. The Bill of 1909⁶ substituted an advalorem duty of 25.25% on the value of all cement. The following table⁷ shows the imports of all foreign cements, Portland cement making up at least 95% of the total for each year.

1. Cement Age, Vol.3, P.95.
2. U. S. Mineral Resources, 1908 P.14.
3. Cement Age, March, 1910.
4. 55 Congress-- Senate Document #188.
5. 61 Congress-- Senate Document # 77.
6. Dingley Tariff Law.
7. U. S. Mineral Resources, 1908, P.14.

Year.	Quantity (bbls.)
1878	92,000
1880	187,000
1882	370,406
1884	585,768
1886	915,255
1888	1,835,504
1890	1,940,186
1892	2,440,654
1894	2,638,107
1896	2,989,597
1898	1,152,861
1900	2,386,683
1902	1,963,023
1904	968,409
1906	2,273,493
1908	842,121
1909 ⁺	427,587

Chapter 2.

THE ECONOMIES OF CEMENT.

The use of cement in concrete-- Its resistance to fire-- Insurance rates-- Cost comparisons.

Civilization protects itself¹, as the supply of one natural material disappears, by substituting others that answer the same purpose. Lumber is an example of a diminishing raw material for which cement is being substituted. In a short time it is likely that lumber as a building material will be largely dispensed with, except for purposes of interior finish, and that cement will be used extensively.

For all concrete work, Portland cement is used almost exclusively because natural and Puzzolan cements are not as well adapted for general use. Natural cement is not as strong as Portland, and Puzzolan will not stand the exposure to dry air, although it may be used in sea water or for foundations. From the time² it was found out that natural cement was not as strong as Portland, the use of the latter increased rapidly. As most engineers seem to have a fixed belief that the best cement is the one which tests the highest manufacturers have turned their attention to making a cement which will test high. Engineers of today demand a quick setting cement, and that is what they get, but it is not as good Portland as that made thirty years ago. Cements are adulterated³ by the addition of natural cement, blast furnace slag, ground limestone, shale, and

1. Chicago Daily News.
2. Cement Age, Vol. 4, P.63.
3. Cummins, American Cements, P.191-8.

ashes. Most of these substances are so similar to Portland cement that chemical analysis fails to show their presence.

The strength of concrete¹ varies greatly. This is due to a number of causes, among which the following are the most important:- (1) the quality and amount of cement used; (2) the kind, size, and strength of aggregate; (3) the thoroughness with which the ingredients are balanced (the densest concrete giving the greatest strength); (4) the method of mixing and the thoroughness with which it is done; and (5) its age. To a certain extent the strength of concrete varies with the amount of water used in mixing; the amount of tamping done in depositing the concrete, and the hygrometric state of the atmosphere during setting.

Concrete is called reinforced² when it is strengthened by steel rods or a steel skeleton. This has provided for the manufacturer an entirely new building material. Indestructable, economical, and fireproof, it offers under most conditions features of advantage over every other type of construction. The development has naturally been greatest in the larger centers of population, but it is extending rapidly to the remoter districts, and, indeed, wherever new buildings are contemplated. There is scarcely any class of manufacture which is not now being carried on in a reinforced concrete building. It is adaptable to any weight of loading, to high speed and heavy machinery, to light machine tools, and to almost any style of design. Recent scientific experiments, as well as actual experience, are favorable to the use of concrete under

1. Reid, Concrete and Reinforced Concrete, P.185.

2. Atlas P. C. Co., Reinforced Concrete as a Building Material.

repeating and vibrating loads.

The cost of putting in steel reinforcement for retaining walls, arches and ordinary construction varies from \$5 to \$8 per ton. For building work it may run up to \$15 per ton. There are several firms furnishing reinforcements for beams and girders fabricated into units or trusses ready to put in place. Some of these make special provision for attaching to slab reinforcement. This method of reinforcement costs from 33% to 50% more than properly constructed single bar systems.

Some of the reasons given by experts as to why concrete is superior to other building materials are as follows; it resists, better than stone, the attacks of acids, as well as the stresses due to the changes in temperature, it has no laminations or planes of weakness, it permits the use of inferior stone in the concrete because the cement acts as a preservative, concrete becomes stronger with age while other building materials become weaker, it is almost entirely immune from fire and consequently commands low rates of insurance, and when used for the building of factories and power houses its resistance to vibration increases the life of machinery and lessens the amount of repairs. Some of the other advantages are economy, ease and rapidity of construction, durability, earthquake resisting qualities, impermeability to moisture, deadening of sound, and the monolithic nature of concrete structures. Some

1. Reid, Concrete and Reinforced Concrete, P.217.

2. H. P. Gillette, Cement Age, Vol. 1, P.182-4.

Prof. Norton's Report on the Baltimore Fire, in Concrete, Plain and Reinforced, by Taylor and Thompson, P.333.

Mr. Perrot, a Philadelphia engineer, Cement Age, Vol 3, P.333.

of the objections² put forth against concrete construction are the difficulties of changing the shafting or machinery, the tiresome effects on employees who are obliged to stand or walk upon such a rigid and inflexible surface for any length of time, and the difficulty of razing concrete structures when they are to be replaced by new ones. But in spite of the obstacles mentioned, its economic advantages tend to bring concrete construction into more and more general use.

The present extensive use of concrete² is the direct outcome of the conservative, patient, and persevering efforts of constructing engineers. The general public in its demands for concrete construction, are considerably in advance of the professions directly interested, and in many cases are greatly disappointed to find their architects unprepared for the work desired. In the past few years, municipal building commissions have, through their inertia, placed many obstacles in the way of the more general adoption of this style of construction, but they are improving fast. During the past few years, much has been done to reduce the cost of concrete construction, and progress continues to be made in this direction. A good average of the cost of ordinary concrete construction is as follows:³

	Hand mixed.	Machine mixed.
Total labor cost(per cubic yd.)	\$.95	\$.59
Cost of material	" <u>4.11</u>	<u>4.11</u>
Total cost per cubic yd.	\$5.06	\$4.70

1. Dean & Main, Consulting Engineers, Cement Age, Vol.3 P.341.
2. Cement Age, Vol.3, P.341-54.
3. Reid, P. 116.

True economy¹ lies in expending money for things that will be useful for the longest possible time without repair. If this test is applied to cement construction, which costs at the outset a little more than frame, it can readily be seen that cement is more economical because a cement house will outlast a frame house by an untold number of years, and be neat and presentable all the time. At the works of the American Cement Company, at Egypt, Pa., a number of concrete dwelling houses have been built, and some of these have been standing since 1885. In this climate they are subject to all variations of heat and cold, but they are still in good condition. At Emporia, Kansas, is a cement block house built twenty years ago, and which is still in good condition after having been struck by lightning and having been through several cyclones. Some of the disadvantages of concrete construction appear when it comes to razing. A small concrete building in Baltimore² has proved so difficult to raze that three contractors have given up the task in disgust. This building, erected in 1902, was one of the first of its character to be built in Baltimore. It went through the great fire of 1904, which, although badly damaging it, left its concrete shell intact. It could have been repaired, but the owners decided to erect a new structure, and thereupon ensued the difficulty of razing it. Dynamite cannot be used on account of the proximity of other buildings. Another owner of a small concrete building in Baltimore, who wanted to erect a modern office building on its site, was told that his

1. Cement Age, Vol.1, P.268. 2. Cement Age, Feb., 1910.

present building was practically indestructable.

Natural and Puzzolan cements will not stand extreme changes in temperature as well as Portland. In the latter the effect of frost does not show unless the water in the concrete has frozen before it has had a chance to enter into chemical union with the concrete, and then if thawing and freezing occur alternately it becomes worthless. If the concrete thaws out and then has a chance to harden before it freezes again, no harm is done. Concrete requires protection from the excessive heat of summer as well as from the intense cold of winter. The former is dangerous because it abstracts the water which is necessary for the proper crystallization of the lime. Moist heat hastens the setting and hardening of cement, but dry heat makes it friable. Frost prevents the chemical union of the water with the cement. Common salt is sometimes used to lower the freezing point of water used for making concrete.

Unless concrete is especially well made it is not impervious to water. Impervious concrete may be made by using voids in the aggregate as small as possible, by using more cement in proportion to the aggregate than for ordinary work, by adding the full quantity of water, and by well tamping the concrete. The Germans make a waterproof cement that is used in this country and which is impervious to water, heat, frost, hot water, sea water, diluted acids, and dampness. A waterproofing powder called "Medusa" is

1. Cement Age, Vol. 4, P. 200.

2. Sutcliffe, Concrete, its Nature and Uses, Chap. 14.

3. Cement Age, Vol. 1, P. 338 & 560.

made by the Sandusky Portland Cement Company¹. This is mixed with the dry cement. It renders concrete impervious to water, prevents efflorescence, and discoloration from rain, without affecting the color, strength, setting, or hardening qualities of the cement. It is not very expensive, costing but \$.12 per pound, and from four to eight pounds being required for each barrel of cement. Te-pe-co² is a liquid waterproofing compound which is applied to the surface of the concrete. It hardens in the pores of the surface thus making it impervious to water, frost, heat, cold, and dampness, without changing the color of the concrete. One gallon of Te-pe-co, costing \$1.00, will cover about 100 square feet on concrete, about 175 square feet on rough plastered surface or about 350 square feet on a smooth plastered surface.

The marked changes and developments³ during the past few years, in municipal, railroad, and building construction, show that cement is gaining rapidly in favor for all kinds of construction. The great problem now is to handle the growing demand without permitting inexperience and ignorance to make the costly mistakes which are sure to attend undue haste and want of preparation. The general public must be brought to recognize that that while cement in concrete construction is a very important element, nevertheless, the other materials with which it is combined, and the manner of mixing, and the placing of the material and forms are also of prime importance, and should be subject to the same rigid inspec-

1. Sandusky P. C. Co. Catalogue.

2. Te-pe-co Catalogue.

3. Cement Age, Vol.5, P.249.

tion that is required in the case of cement. The public demand for cement and concrete construction cannot be met at this time, not for lack of cement, but because we have relatively so few builders and contractors qualified by experience to undertake this class of work. This is especially true in the construction of residences.

The uses of cement¹ have extended almost beyond our comprehension. The cement industry has made great strides and still the end is not yet. Indeed, at the present time it is only in its infancy. Great improvements are made from year to year in methods of working and in machinery for making cement products. Cement has made possible, at a reasonable cost, the modern skyscraper, the American subway, the New York water supply costing \$160,000,000, the Grand Central and Pennsylvania R. R. terminals each costing \$50,000,000, the Pennsylvania R. R. tunnels costing \$75,000,000, the New York State Barge Canal costing \$101,000,000, the new bridges to Brooklyn costing \$100,000,000.

Cement is also used² for wharves, breakwaters, dams, bridges, mine supports, factories, warehouses, dwelling houses, concrete blocks and bricks, retaining walls, barges, battleship linings, reinforced sewer pipe, piles, roofing slabs, flag stones, telegraph poles, reinforced beams, imitation stone ornaments for buildings, railroad ties, paving stones, high chimneys, linings for steel smokestacks, burial vaults, and caskets.

"The up-to-date American farmer³ can have his farm fenced with

1. Cement Age, Vol. 8, P. 76.

2. Chicago AA Portland Cement Catalogue.

3. The Iowa Engineer, Jan. & Mar., 1909.

cement posts, and his low lands drained with cement tile. He can have cement storage tanks to hold water for his stock, he can water his stock in cement troughs, he can house his stock in cement barns and sheds, he can keep his fodder in cement silos, he can have cement nests for his fowls. He can live in a cement house, his wife can bake her bread in a cement oven, she can raise flowers in cement vases, she can fry her buckwheat cakes on a cement griddle, and spread them with butter made in a cement churn. The farmer can go to the barn on a cement walk, and his wagon wheels can now be made of cement. Finally when he comes to leave this earth his body can be laid away in a cement burial vault, and a cement tombstone erected to his memory! Other uses of cement¹ about the home are for cellar floors, stairways, steps, wall foundations, chimney caps, well curbs, cisterns, horse blocks, clothes posts, foundation piers, porches, lattices, hog pens, chicken houses, ice houses, carriage houses, garages, root cellars, greenhouses, hotbed frames, and lawn fountains.

It is only within comparatively recent years² that any serious attention has been paid by architects, engineers, and builders to the advantages offered by cement for residence construction. The things which have brought cement houses quite prominently before the home builder, are the popular demand for a fireproof home and the desire for a building material at once economical, sanitary, indestructable, warm in winter, cool in summer, and one adapted to practically every style of architecture. The concrete house has

1. Atlas P. C. Co., Concrete About the Home and on the Farm.
2. Cement Age, Vol. 8, P. 336.

made its advent and is here to stay. From the economical standpoint alone, it surpasses all other kinds of construction. Architects are beginning to take up this material, and it is only a question of time before the majority of houses will be built of concrete, and they will be more beautiful than houses of other materials. There is a large amount of ornamental architectural work being produced in this country, and cement is the most suitable material for this purpose because of the opportunity for the architect to secure permanent and strong mass and form. While it was thought that artistic houses could be built out of cement, architects hesitated to draw plans for cement houses because they were not familiar with the material. The prizes offered¹ by the Association of American Portland Cement Manufacturers brought out some very good plans for dwellings of moderate cost in monolithic concrete and hollow blocks. The response from the architects was very gratifying, showing that from the strictly professional standpoint, they were keenly interested in the subject. The result of this competition was that a great impetus was given to the building of artistic houses of concrete. The following table² shows the relative cost of different walls for residences.

Kind of wall.	Cost per square foot.
Brick, 13 inch wall,	\$.36 to \$.50
Hollow tile, 13 inch wall,	.36 to .50
Cement block, 8 to 12 inch wall,	.18 to .35
Hollow reinforced wall, 8 to 12 inches thick,	.15 to .25
Monolithic wall, 6 inches thick,	.11 to .18
1. Cement Age, June, 1907. 2. Cement World, Dec. 1909.	

The cement block business¹ is growing enormously, blocks being used in place of stone or brick for nearly all masonry construction. Ordinary walls of concrete blocks may be built at from 50% to 75% of the cost of ordinary brick or cut stone walls. Ornamental cement blocks are used extensively for decorating brick and cement residences, office buildings and factories. For some ornamental designs, stamped metal forms are used. Others are molded in sand, while the finest are those made in glue molds. As the manufacturers are taking up the business of molding special designs, architects are turning their attention more and more to cement block and brick houses. Their cost is only a small fraction of what such ornaments in cut stone would cost, and they are not affected as much by the weather. Fine concrete can be poured into a mold just as plaster can, and as the resulting work of art will be unharmed by the ravages of the elements, any kind of statuary or garden furniture may ^{be made} in almost any desired color. Mr. E. C. Carter², before the Concrete Machine Manufacturers Convention at Detroit, speaking on the subject of ornamental products in cement stone, said that the labor of cutting by hand a Renaissance baluster in natural stone would cost \$10.00, while the same could be made in concrete at a labor cost of \$.10.

Although for railroad construction³ the cost of concrete is higher than ^{the cost of} some other materials, all of the railroads are putting in concrete in all possible places because it greatly reduces the

1. Rice, Concrete Blocks.
2. Cement Age, Vol.4, P.188.
3. Cement Age, Vol.3, P.469.

cost of maintenance. In many cases bridge costs have been reduced by the use of concrete, while their maintenance cost is practically nothing. Reports from railway officials regarding the behavior of concrete ties, show that they are thoroughly practical and trustworthy. The Southern Pacific¹ has given these ties a test of several months and is so well satisfied with them that it is now laying 1500 of them in Louisiana. The length of life of concrete ties is not definitely known, but it is thought that it will be several times the life of wood ties. The best quality wood ties² cost about \$.65 apiece, and concrete ties cost about \$1.18 apiece. Other uses which the railroads make of concrete are for building bridges, viaducts, retaining walls, culverts, abutments, passenger stations, and tunnels. In the use of concrete³ for retaining walls from ten to forty feet in height, there is a saving of from 20% to 45% in cost by using reinforced instead of plain concrete.

In Denver, recently, the Improvement Association appointed a special committee to investigate and report upon the relative merits of concrete and vitrified sewer pipes⁴. They learned that some 84 American cities are giving cement pipe the preference, for both sanitary and storm sewers, claiming that cement pipe is more efficient because always perfectly true, therefore rendering the joints absolutely tight; that it is more durable because it will stand moisture and freezing; that it is less brittle, becoming tougher and harder as it grows older. The reports of the various city engineers showed that no ill effects had ever been shown in

1. Cement Age, Dec. 1909. 2. Camp, Track Notes. 4. The Contractor.
3. Reid, Concrete and Reinforced Concrete, P. 614.

well formed cement pipe, from the effect of alkali or acid in ordinary soil or sewerage. The committee also reported that there was a saving of from \$.25 to \$.70 per foot over clay pipe, and further, that concrete pipe was absolutely permanent. Some cement pipe which has been in use in Denver for over 25 years was examined and found to be in better condition than when it was laid. Tests of reinforced concrete water pipe for high pressure service, which the United States reclamation service has been conducting at Hermiston, Oregon, have proved so satisfactory that the government will install a two mile line of reinforced concrete pipe in one of its irrigation projects. The advantages of the concrete pipe, according to the engineers are that it is about one-half as expensive as steel or iron pipe, and is just as permanent.

The cost of eight inch cement pipe¹ built in place in New York state is \$.0663 per linear foot, as against a cost of \$.175 per linear foot for the same size vitrified sewer pipe. The following table² shows the prices of clay and cement tile in Iowa.

Size of tile. Cost of clay tile per 1000 feet. Cost of cement.

10 inch	\$ 85.00	\$ 85.00
12 "	110.00	100.00
14 "	120.00	115.00
16 "	260.00	225.00
18 "	350.00	325.00
20 "	500.00	400.00
22 "	575.00	450.00
24 "	675.00	550.00

¹•Cement Age, Vol.3, P.171. ²Iowa Engineer, Jan. & Mar. 1909.

Cement brick for sewer work cost \$8.50 per 1000, while ordinary sewer brick cost \$9.40 per 1000.

In making pile foundations¹, concrete piles will support twice as much as the same number of wooden piles, besides having a much longer life. In some of the new buildings for the Naval Academy at Annapolis, it was found that concrete piles could be used instead of wooden ones, and at a saving of 50% on the cost of the entire foundation.

As yet there has been no uniform rate for insurance² on concrete buildings. In different parts of the country different rates prevail. Reinforced concrete ranks with the best fireproof materials, and it is this quality perhaps more than any other which is responsible for the enormous increase in its use for factory construction. Intense heat injures the surface of the concrete, but it is so good a non-conductor that, if sufficiently thick, it provides ample protection for the steel reinforcement, and the interior mass is unaffected even in unusually severe fires. When reinforced concrete first came to the front for factory and warehouse construction, insurance companies hesitated to assume such buildings as first class risks. However, examination and tests have gradually convinced the most skeptical of their true fire resistance, until now structures of this material are sought after and given the lowest rates of insurance. The insurance companies have found out that a well-designed reinforced factory with continuous floors offers security against disastrous

1. Cement Age, Vol.3, P.248.

2. Cement Age, Vol.1, P.461.

fires and total loss of structure; reduces danger to contents by preventing the spread of a fire; prevents damage by water from story to story; makes sprinklers unnecessary in buildings whose contents are not inflammable; reduces danger of panic and loss of life among employees in case of a fire. In consideration of the question of insurance on reinforced factories¹, the problem simply resolves itself into a determination of what the fire and water damage will be in the event of a fire compared with that in other types of factory buildings. For this purpose concrete factories may be divided into two classes: (1) those having contents which are not inflammable or readily combustible. In this class, if wooden window frames and partitions have been eliminated, the building as a whole becomes practically proof against fire, provided there are no outside exposures, protection against which would require special precautions. (2) Those buildings having contents which are more or less combustible, and which have in their construction small amounts of inflammable material, such as wooden window frames and top floors. In this class the burning of contents is the cause of damage to the building- the extent of which is determined by the character of the contents. Of the two, the latter class is the one ordinarily met, and with which the question of insurance cost is usually concerned. The character of the occupancy, details of construction and conditions of various kinds inside and outside the factory, and in the various communities, have such direct bearing on rates that any statement of comparative

1. Atlas P. C. Co., Reinforced Concrete in Factory Construction.

cost must be extremely approximate, but perhaps of value as showing somewhat the relative costs. The following table¹ is made upon the basis of buildings which have no private fire apparatus except such as pails and standpipes, but which are located in cities having good fire departments.

Approximate yearly cost of insurance per \$100.00.

	All concrete.		Brick mill construction or open joists.		Wood mill construction or open joists.	
	Bldg.	Contents.	Bldg.	Contents.	Bldg.	Contents.
General warehouse	\$.20	\$.45	\$.60	\$1.00	\$1.00	\$1.25
Wool Storehouse	.20	.35	.40	.60	.75	1.00
Office building	.15	.30	.35	.50	1.00	1.25
Cotton factory	.40	1.00	1.00	2.00	2.00	3.00
Tannery	.20	.40	.75	1.00	1.00	1.00
Shoe factory	.25	.80	.75	1.00	1.50	2.00
Woolen mill	.30	.80	.75	1.00	1.50	2.00
Machine shop	.15	.25	.50	.50	1.00	1.00
Mercantile building	.35	.75	.50	1.00	1.00	1.50

For brick or wood buildings in small towns without the best of water and fire departments add \$.25 to the above amounts on general storehouse, wool storehouse, office building, tannery, machine shop, and general mercantile building. Add \$.50 to the amounts on cotton factory, shoe factory, and woolen mill.

1. Boston Manufacturers Mutual Fire Insurance Co.

Chapter 3.

THE PRESENT STATUS OF THE INDUSTRY.

The development of the cement industry--New plants and their location--Resources of the different states--Present development of the industry.

In view of the fact that cement seems to be the coming building material, many people are willing to invest in any kind of a cement plant. When properly located¹, constructed, and managed, cement plants have made very satisfactory returns to the investor, and even poorly managed or badly located plants have made some returns to their stockholders. This latter class has been crowded out of the field by the more economical plants, and a cement investment is now practically on a level with other industrial investments. A new plant needs to be fairly capitalized, that is, the capitalization must at least be equal to the amount of money actually spent on the construction of the plant, plus the working capital required. This consideration fixes the minimum, and the maximum satisfactory capitalization cannot be much larger. It should be such that the plant could pay a reasonable industrial rate of dividend, over a long series of years, on the total capitalization.

Most of the early cement plants were erected by small groups of men who had capital enough of their own, and it is only within the past few years that the cement industry has been made the basis for wholesale attempts at robbing the investing public

1.Eckel, The P. C. Industry from a Financial Standpoint.

through the agency of overcapitalized projects and misleading prospectuses. In 1908¹, there were 113 cement plants in the United States, having a total capitalization of \$141,587,000. These actual plants had a total annual capacity of over 85,500,000 barrels, while their total production in 1907 was less than 49,000,000 barrels. In other words, the existing plants could not run profitably at much over half their rated capacity. At the same time (1908), 114 new plants were in the various stages of promotion. These projected plants had a total capitalization of \$160,125,000 and a total capacity of 62,000,000 barrels. A glance at the figures given above will show that, with an annual output of not much over half the capacity of existing plants, preparations are being made to add 62,000,000 barrels to the yearly capacity, and that the proposed plants are much more heavily capitalized than the existing ones are. It is interesting to note² in this connection that most of the cement companies that have failed have done so because of an excess capitalization. It is also an interesting fact that only about five per cent of promoted companies ever live to pay dividends to the original stockholders. The promotion of cement companies is possible almost anywhere, because excellent cement materials are common in nearly all parts of the United States, and consequently the commercial value of undeveloped deposits is necessarily low. In most of the Eastern, Southern, and Middle states there is no difficulty² in securing lands containing lime stone suitable for cement manufacture at

prices ranging from \$5 to \$50 per acre, and it is only exceptional instances where any cement deposit would be valued at more than the latter price. The value of the location depends less on the character of the materials than upon other factors. The characteristics of a good deposit of raw material¹ may be summed up as follows:- the raw material must be of correct chemical composition for use as a cement material; its physical character must be such that the operations of quarrying, drying, and grinding can be carried on at a minimum cost; the size of the deposit must be great enough to keep a large plant supplied with material for at least twenty years. A number of southern promotions contemplate the use of a raw material whose high percentage of alumina would result in the making of a low grade cement, while its moisture content would make operating costs high. In other localities² variable or excessive percentages of magnesia have developed after operation has commenced, and similar chemical defects appear in many propositions. The material, if a limestone, must contain as small a percentage of magnesium carbonate as possible, but under present conditions as much as 5% or 6% is permissible. Free silica, in the form of chert, flint, or sand should be entirely absent, but may be present in quantities of 1% or less. A clay or shale should have the proper proportion of silica, alumina, or iron, and should be free from sand or gravel. Alkalies and sulphates should not exceed 3%. The nearer a limestone approaches in composition to the mixture used in Portland cement manufacture, the better it is for use.

1. Eckel, The P. C. Industry from a Financial Standpoint.

The approximate composition¹ of a Portland cement mixture is 75% of lime carbonate, 20% silica, alumina, and iron oxide together, with the remaining 5% including any magnesium carbonate, sulphur, and alkalis that may be present. Thus it may be seen that Portland cement can be made from a large number of raw materials.

In selecting a location for a new plant, or in attempting to put a valuation on a location already selected, a number of distinct and to some extent independent factors are involved, all of which should be given due consideration. The main points² to be noted are : suitable raw materials, good transportation routes, an available fuel supply, accessible markets, good labor supply, and the liability of competition, both present and potential. Ignorance of the importance of these factors frequently leads to an overestimate of the value of some particular plant location, or to the acceptance of an inferior location when a better one might readily be secured. When a successful existing company is looking for a location for a new mill, it will generally make sure of the above points. It will endeavor to put the mill where it will pay the greatest returns on the investment, as its interest is in the success of the business, and not in the booming of any particular piece of property. Even under these conditions, there have been instances of remarkably bad locations by previously successful companies. The promoted plants² furnish the most striking examples of bad location. This is due to the fact that the promoter invariably begins at the wrong end of the problem. Instead of

1. Eckel, The P. C. Industry from a Financial Standpoint.

selecting first the general territory in which he wishes to build, and then, by careful study picking out the best possible location in that territory, the promoter usually begins by buying a piece of limestone land because it is cheap, or because it is located in or near a town whose Board of Trade will offer "suitable inducements to new industries", or because it is near an established and successful plant. Generally these three reasons are good enough for the promoter, but not one of them has anything to do with the earning power of the plant. It will be found on examining the average cement plant prospectus that it usually contains statistics regarding the past growth of the industry, more or less truthful statements concerning the profits of cement manufacture, a few analyses of the raw material to be used at the proposed plant, and attractive estimates of earnings and dividends. Little or nothing definite will be said regarding shipping facilities, fuel costs, labor supply, markets, or competition. In every case the burden of proof should rest on the promoter. In every case the man who proposes to build a new plant should be able to give clear and definite reasons why a plant of a certain size should be built at a particular location. The proper size of a cement plant depends within certain limits, upon the available market for its product. Naturally a mill of large capacity is expected to operate at a less cost per barrel than a small mill. There is, however, in almost every manufacturing business, a point beyond which increase in size is only obtained by doubling up. It has been found that

a plant capable of producing from 2500 to 3000 barrels of finished product daily is an ideal one, wherein the maximum of efficiency may be combined with the greatest economy. In designing it, the possibility of expansion to supply a considerable increase in capacity, may be provided for without any notable increase in cost.

In considering the earning possibilities² of a new plant, without present local competition, the certainty of future competition must not be lost sight of. It is not possible to prevent this, but it is possible to select the site so that future competitors must operate at more or less of a disadvantage. Promoted plants do not usually take this into consideration.

Since fuel² is such an item in the total cost of cement manufacture (it takes about 200 pounds of coal to make one barrel of cement) a plant should be so located as to secure a regular supply of cheap and good fuel. The fuels used are powdered coal, natural gas, and producer gas. Powdered coal is used in 79 plants, operating 753 kilns; oil is used in 8 plants, operating 64 kilns; natural gas is used in 6 plants, operating 58 kilns; and producer gas is used in one plant, operating one kiln. Coal is used largely in the Middle, Eastern, and Southern states, where it can be obtained at from \$1.50 to \$3.00 per ton at the mill, the cost depending more on the location of the plant than on the quality of the coal. Oil is used in Arizona, California, Texas, and Washington. Natural gas is used by all of the Kansas plants. At 200 pounds of coal per

barrel, the fuel cost will range between \$.15 and \$.30 per barrel. Gas will cost from \$.25 to \$.35 per barrel.

All of the states of the union² have resources favorable for the manufacture of Portland cement, except Connecticut, Delaware, Idaho, North Dakota, Louisiana, and Wisconsin, but there is no available fuel supply in the New England states, the Carolinas, and Florida. At present (1909) there are no plants in Arkansas, Indian Territory, Mississippi, Minnesota, Montana, Oregon, Nebraska, Nevada, West Virginia, and Wyoming. The economic conditions are favorable for the development of a large industry in Alabama, ~~the~~ the chalk deposits being of almost the exact composition for the manufacture of Portland cement. Coal of good quality occurs within reasonable distance of the cement beds and labor is abundant. The market is practically unlimited as transportation is cheap to Central and South America. At present Alabama has only two producing plants. Arizona has one plant owned and operated by the government. The economic conditions there are not favorable for the extension of the industry. Until 1903 there was but one Portland cement plant in California, but at present there are four in operation, all using oil for fuel. Colorado has two plants in operation, but the materials there are only fairly good. Only one plant is in operation in Georgia, and the material used is the refuse from a slate quarry. Illinois has five plants, four of which use limestone, and the other uses blast furnace slag and pure calcite. Indiana is the second largest producer of Portland

cement in the country, having seven plants, some of which use a mixture of marl and clay, and the others use hard limestone and clay. There is only one plant in Iowa, but conditions are favorable for more. Kansas has seven plants, all using limestones and shales. Kentucky has one plant in operation, but the indications are that more will be erected soon. Maryland has but one plant which uses limestone and shale. Missouri has four large plants in operation and it seems probable that this state will soon become an important factor in the cement production of the United States, because the thickest and purest limestones of the state outcrop along the banks of the Missouri and Mississippi rivers, thus assuring the plants cheap fuel and transportation. New York has seven plants in operation, and except Pennsylvania, has produced Portland cement longer than any other state. Most of the mills here use marl and light gray clay. In Ohio there are eight plants, four of which, in the eastern part of the state, use limestone and shale, while the other four, in the western part of the state, use marl and clay. Oklahoma has two comparatively new plants in operation. New Jersey has three very large plants, located in Warren county, and all employing the same materials used in the Lehigh district of Pennsylvania. Pennsylvania is the oldest and largest producer of Portland cement in the United States. It has seventeen plants, most of which use the Trenton limestone which is found in the Lehigh Valley. In 1903, the Lehigh district (which includes the three plants in New Jersey) produced 60% of the Portland cement produced in this country. South Dakota has one plant, which uses

chalk and clay. Tennessee has one plant, using limestones. In Utah there are two plants near Salt Lake City, using limestone resembling that of the Lehigh Valley. Texas has two plants in operation, using limestones. Virginia has one plant which uses limestone and shale. Washington has two plants, using rock which resembles that of the famous Lehigh district.

The Portland cement industry² of today owes much of its mechanical perfection to the efforts of American inventors. While many mechanical details are of course covered by minor patents, those claims which are likely to have any serious effect on the future of the industry may be grouped as follows; patents relating to special types of grinding machinery, patents relating to the burning process, patents on special products, such as the high-iron marine cements and the low-iron white cements, and patents covering by-products, such as sulphur and the alkalies. Numerous patents have been taken out in connection with various phases of the cement industry, but it is only within the past few years that the patent question has become of prime importance to the industry. This recent development is due to the organization and growth of a great patent-holding corporation. Late in 1906, the North American Portland Cement Company was organized, with a capital stock of \$10,000,000, this stock being held by the Atlas, Alpha, American, Lehigh, Lawrence, and Vulcanite cement companies. The North American company took over from the Atlas company, the United States rights to the Henry and Seaman patents, which cover

1. Eckel, The P. C. Industry from a Financial Standpoint.

certain methods for the burning of pulverized coal in cement kilns. It has since acquired the Edison long kiln, and the Carpenter patents. The companies now licensed under this system include the six companies which control the North American, and also the Whitehall, Northampton, Dexter, Edison, Nazareth, Pennsylvania, Penn-Allen, Catskill, Buckhorn, Phoenix, Bath, and Glens Falls cement companies. In January, 1907 these licensed companies organized as the Association of Licensed Cement Manufacturers. The purposes of their organization include the general betterment of the mechanical and chemical processes used in the manufacture of ~~of~~ cement, the improvement of the quality of the cement, the establishment of an association laboratory for technical tests and experiments, and the dealing with matters of traffic and shipment. Nearly 70% of the output of the Portland cement industry in the United States is represented by this association, this being equal to the combined output of England and France, more than that of Germany, and double the output of England, the pioneer Portland cement manufacturing country. This association, with its facilities for tests and experiments, and by reason of its assistance in obtaining proper shipping facilities and rates, is expected to be of great benefit to its members.

Ten years ago², the business of manufacturing Portland cement was confined to a number of comparatively small mills, each of which was practically independent. Today there is a noticeable degree of concentration of interest in the industry, and three

processes are at work to increase steadily this concentration. It is clearly impossible for any one organization to gain control of the supply of raw materials, so that in this industry the most effective basis for monopoly is not available. The ownership of comprehensive basic patents would afford a peculiarly serviceable type of control, inasmuch as patent monopolies are legal in form. The three factors¹ which make for concentration of control are the normal growth of profitable plants, consolidation by stock control, and the growth of the patent-holding company. A well located and well managed plant always has opportunity for expansion which is denied to plants of less technical or financial soundness. Lack of growth in cement plants has been due, in the majority of instances, not to defective raw materials or to lack of technical skill, but to unwise financial management either at inception or during the active life of the company. Several strong groups of plants connected by stock control rather than by direct ownership are now in existence. The most important¹ of these are the Nicholson group, composed of the Iola, United Kansas (Kansas, Independence, and Indian), Dixie, Iowa, and Texas Portland cement companies; the North American Portland cement company, controlling the following:- Alpha, Martin's Creek, American, Central, Reliance, Tidewater, Atlas, Lawrence, and Lehigh Portland cement companies; the United States Steel Corporation, owning the three plants of the Universal Portland cement company; the Dingee group, composed of the Standard, Santa Cruz, Northwestern, Atlantic, Northampton, L. Eckel, The P. C. Industry from a Financial Standpoint.

and Quaker Portland cement companies; the Sandusky group comprising four plants; the Cowham group, composed of the Peninsular, South-western States, Western States, and Northwestern States Portland cement companies; the Cement Securities Company, composed of the Portland Cement Company of Colorado, the Portland Cement Company of Utah, and the Union Portland Cement Company. The effect of this concentration will be to gradually limit the territory over which any one group can send its product at a profit, because, with the growth of new plants, the distributing area of each district is gradually restricted.

In all of the large companies, the work is facilitated by ~~by~~ having different departments to attend to the different kinds of work. Most companies have operating, sales, order, credit and collection, accounting, inspection, and publicity departments. The operating department has charge of receiving raw material, manufacturing it, packing the finished product, and shipping it. The names of the other departments are self explanatory. Some companies hire expert chemists¹ to try to make new compounds which will improve cement or which will facilitate its use. These chemists also try to utilize the by-products, the importance² of which may be seen by the fact that a plant of 5,000 barrels per day capacity will liberate 1,084 tons of carbon dioxide daily. Sulphuric acid, potash, and soda may also be made from the kiln gases.

The costs of Portland cement manufacture are, of course, greatly lower than during the early history of the industry. Part of

1. Cement Age, Vol.1, P.110 & 359-365.

this decrease is easily understood as being merely the gain shown in any well-conducted industry as its machines and men get gradually fitted to their work. But this regular economy, which is not progressive, but shows most in the first years, is not the explanation of the bulk of the cost reduction which has been effected in cement manufacture. The great decreases¹ came in three abrupt steps, coincident with radical changes in the methods of manufacture. In 1885, an American cement plant would have shown costs somewhat larger than an English plant, due to the heavier American labor cost, which was not entirely compensated for by cheaper fuel. The general adoption of the rotary kiln changed this relation, and was the cause of sharp reductions in the manufacturing costs. A second fall in costs was noticeable when powdered coal became the standard fuel in the rotary kiln. The last progressive step in the industry, the adoption of the long kiln, was taken at a time when coal and labor were becoming more expensive, and so far has shown a gain in output with a slight saving in cost. So long as there are no radical changes in our present methods of cement manufacture, no marked decrease in operating costs can be expected. The main elements in the problem are determined by nature. To make 400 pounds of cement,¹ about 200 pounds of coal must be burned, and 1100 pounds of material must be pulverized. As coal can hardly be expected to decrease in price in the future, and as the other elements of cost are practically unchangeable, there is little room left for economy, so that further important decreases in

1. Eckel, The P. C. Industry from a Financial Standpoint.

manufacturing costs can hardly be expected.

One of the recent economies effected in advertising and extending the use of cement, is the organization, by the various large cement companies, of the American Cement Products Exhibition Company. The object of this company is to give cement shows and exhibitions, and to do everything in its power to extend the use of cement. It has demonstrated the applications of cement to other industries and the people as a whole are rapidly taking them up.

It has been a matter of surprise² to those engaged in other industries to note the rapid growth of the cement industry. They profess not to understand how cement has come into such universal use in comparatively few years. The explanation is simple if we consider the relation of cement to other industries. There has been a rapid decline in the lime industry because of the substitution of cement for lime in mortar. Thus, while attempting to restrict the use of cement in the form of concrete, we find the brick industry largely dependent upon cement for the best results in the use of its own material. The brick and terra cotta manufacturers have had additional demands for their products to use for facing on concrete buildings. In the matter of steel, the Iron Age, which speaks with authority for that industry, has come to the conclusion that the use of reinforced concrete has been a decided benefit to the steel industry. Thus we find on every side, recognition of the worth of cement and concrete by other industries, and if those said to be in competition with it demand cement for

their own uses, as furthering their own interests, it ought not to be a matter of surprise to find it generally adopted by individuals and interests not in conflict with it in a commercial sense.

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